TI:

Semiconductor Diodes

Unclassified

Safety & Environmental Impact is “LOW”

TI: Semiconductor Diodes

Termimial Learning Objective

ACTION:

Given a schematic, identify the biasing of the diode, its conduction & the respective voltages at test points, pertinent to terms & operational characteristics of the semiconductor diode, Positive & Negative Limiters.

CONDITIONS:

Without reference.

STANDARD:

A minimum of 7 correct answers out of 10 Questions.

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Introduction

This will be the 2nd time that Semiconductor Diodes are introduced. This lesson will be a little more comprehensive than the previous lesson. Several different types of Ckts will be illustrated w/ the diode as the key Component.

Atom

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Atom:

1. **Composed of 3 Basic particles, Protons, Electrons & Neutrons.**
2. **An Atom requires balance, an equal No. of Protons & Electrons.**
3. **When an atom has more of one particle than the other the atom acquires the charge of the greater.**

+ Ion, Has more Protons than Electrons,

- Ion, Has more Electrons than Protons.

Conductor;

Has loosely bound electrons in its outer or Valence ring, they are easily displaced.

Insulator;

Has tightly bound electrons in its outer or Valence ring, they are not easily displaced.

Semiconductor;

Has at least 4 electrons in the outer or Valence ring, it is neither a conductor nor an insulator. In its pure state it makes a better insulator than conductor. 4 electrons allows the easy bonding w/ other materials.

Doping

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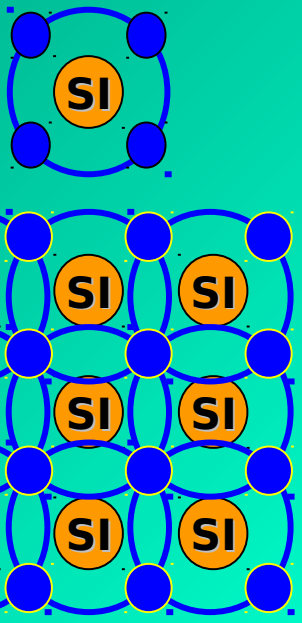
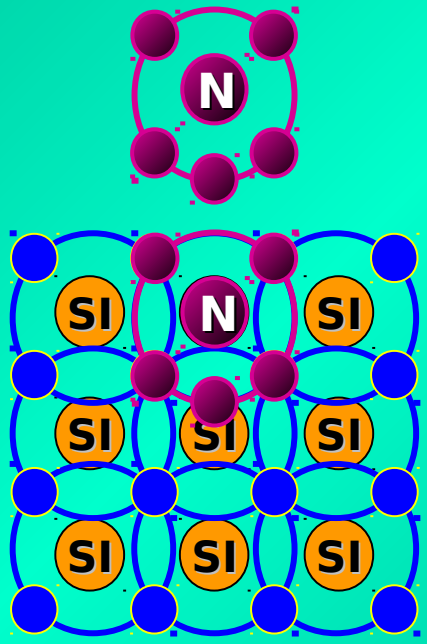
Doping: The process of adding impurities to the Intrinsic material giving the material a **Positive** or **Negative** characteristic.



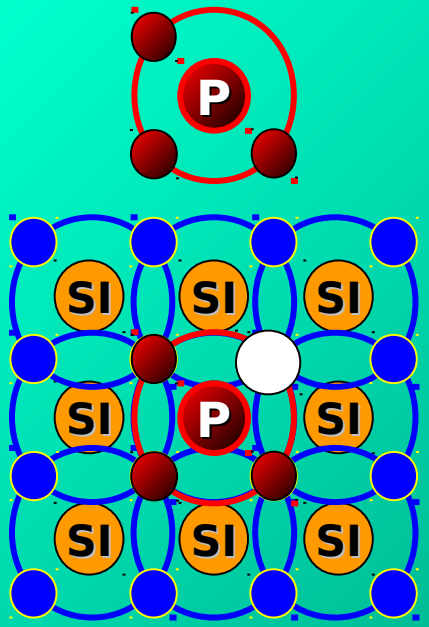
Covalent Bonding;

Shares its 4 electrons w/other atoms and forms a pure crystal.



Pentavalent Doping;

Donor Material. Impurities that have an excess of electrons. N type Material, called Electrons. - charged



Trivalent Doping;

Acceptor Material. Impurities that have missing electron, called Holes or P type Material. + charged.

N Material

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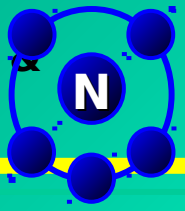
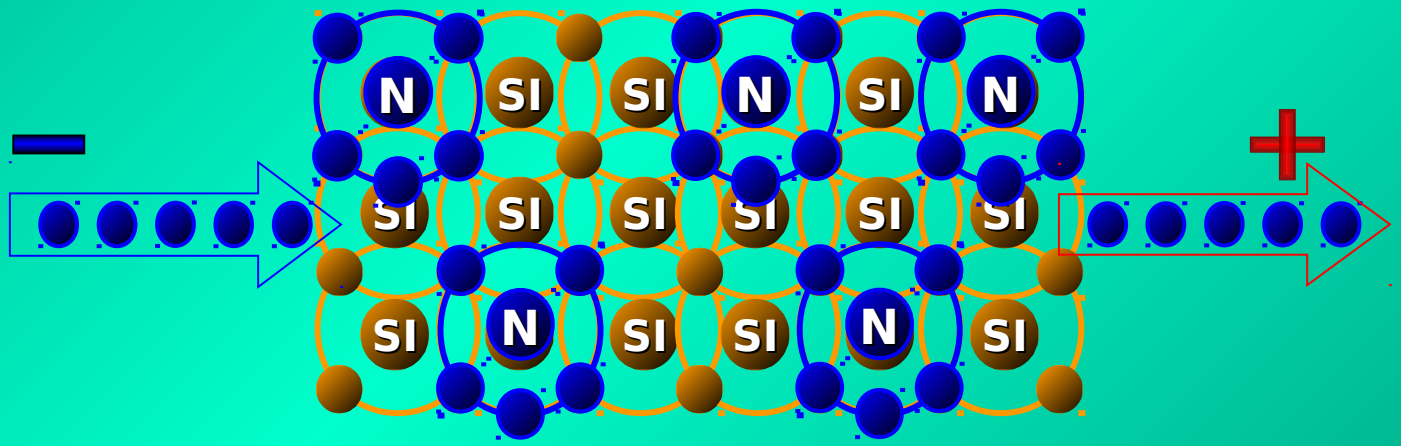
N Type Material:



Pentavalent impurities, Donor Material W/an excess electron in the covalent bond w/Silicon displays a Negative charge.

Majority Carrier is Electrons.



P Material

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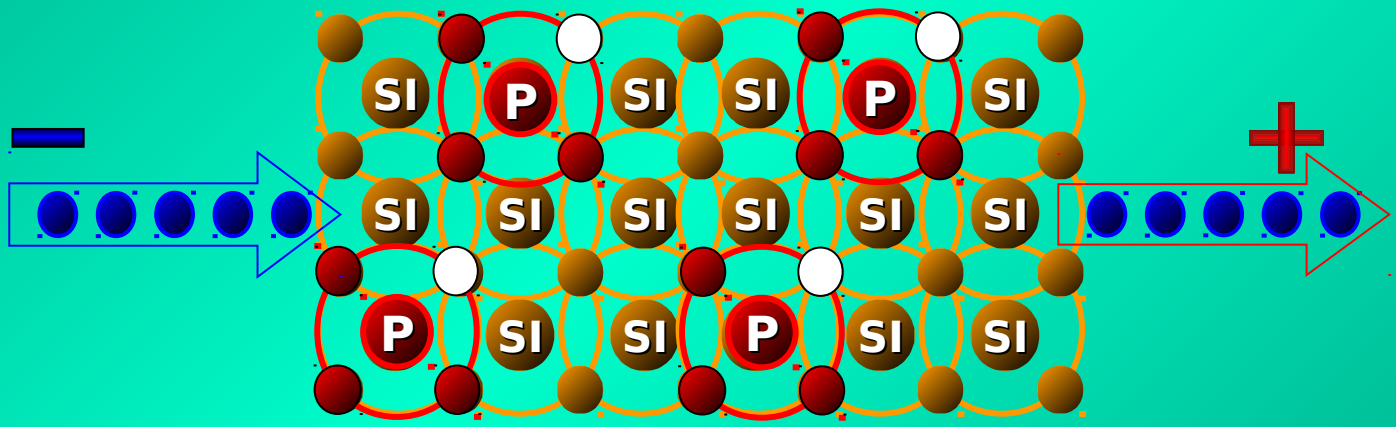
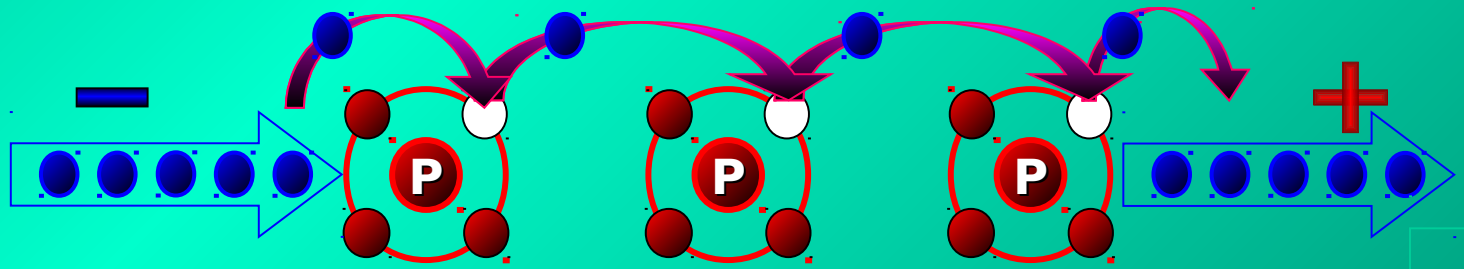
P Type Material; Trivalent impurities, Acceptor Material has a missing electron in the covalent bond w/Silicon, & displays a **Positive** charge.

Majority Carrier is **Holes**.





Review

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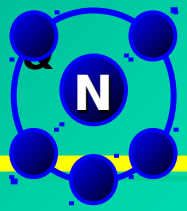
Review: 2 **Majority Current** Carriers, **Holes** & **Electrons**.

N Type Material:



Pentavalent impurities, Donor Material w/an excess electron in the covalent bond w/Silicon displays a **Negative** charge.

Majority Carrier is **Electrons**.

P Type Material:

Trivalent impurities, Acceptor Material has a missing electron in the covalent bond w/Silicon, & displays a **Positive** charge.

Majority Carrier is **Holes**.

2 Current Carriers: **Majority & Minority**

Due to the stay impurities inherent in silicon. Results in current flow in the opposite direction of Majority flow. Becomes evident in heat, leakage and break down of the device.

Minority Current carrier

Depletion Region

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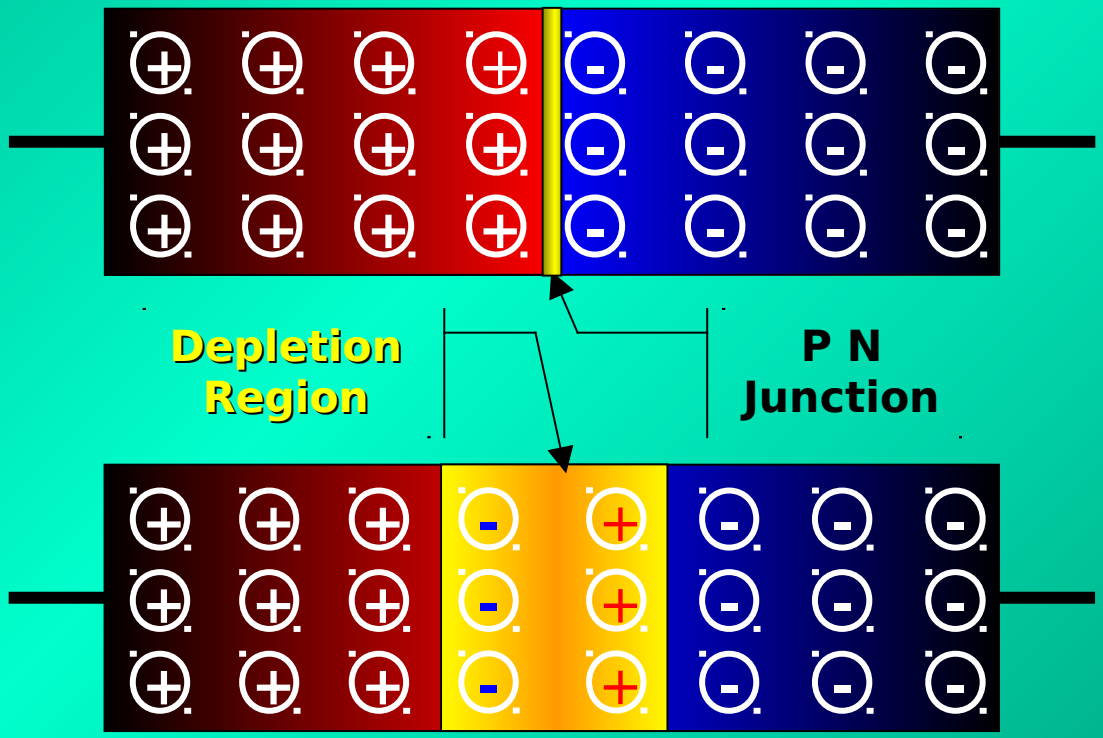
Depletion Region:

Fusing at the Junction of P & N type material causes the area on each side to become Ionized , thus depleting the area on each side of the Junction of Current Carriers.



Forward Bias

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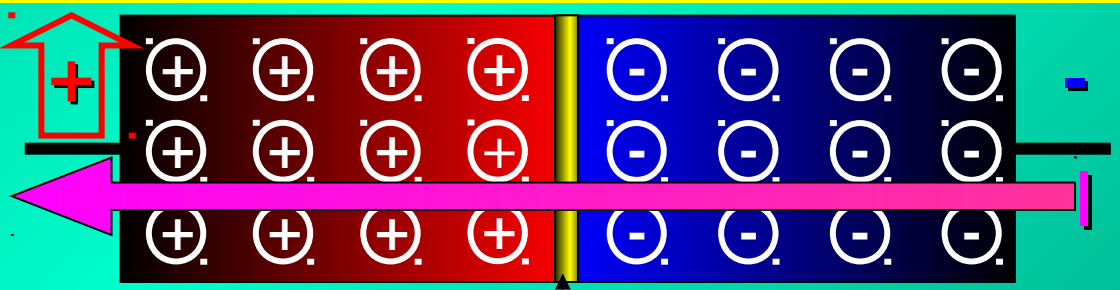
Forward Bias Mode:

BIAS; The difference of potential between 2 points or elements.

1. **Occurs when the difference of potential or polarity agrees w/the polarity of the material.**
2. **Occurs when the Junction Barrier Potential is met, the depletion region collapses @ 600 mV for Silicon & 100 mV for Germanium.**
3. **The Diode Acts like a short, Resistance is minimum & Current flow is maximum. The Diode will Drop 600 mV across it.**



Reverse Bias

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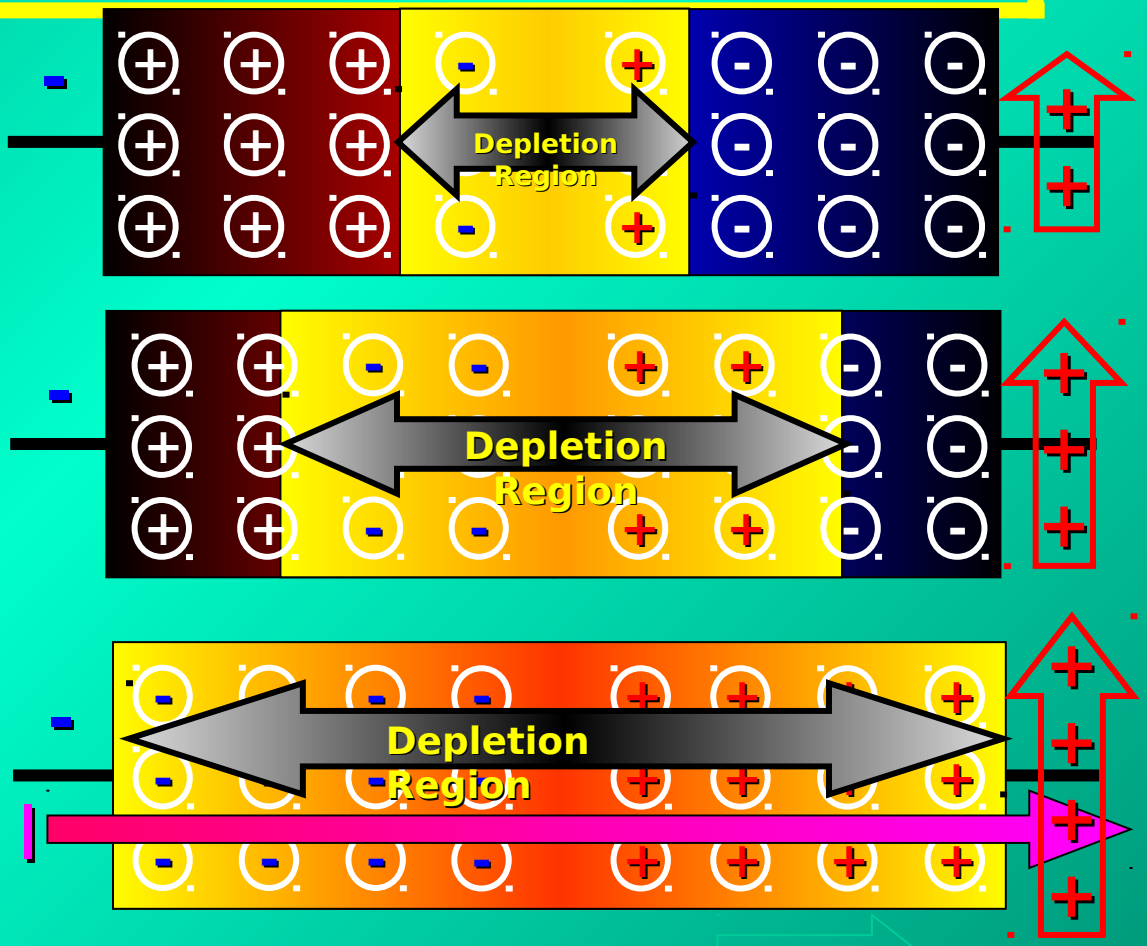
Reverse Bias Mode:

Occurs when the polarity or the difference of potential <u>does not</u> agree W/ the polarity of the material.

W/the ↑ of reverse voltage, Resistance ↑ with the expansion of depletion region. The Diode <u>Acts</u> like an open.

If the reverse voltage is increased beyond the limits of the device, [PRV] Peak Reverse Voltage, or Peak Inverse Voltage [PIV], rapid current flow results [Avalanches] & destroys the diode.



Symbol

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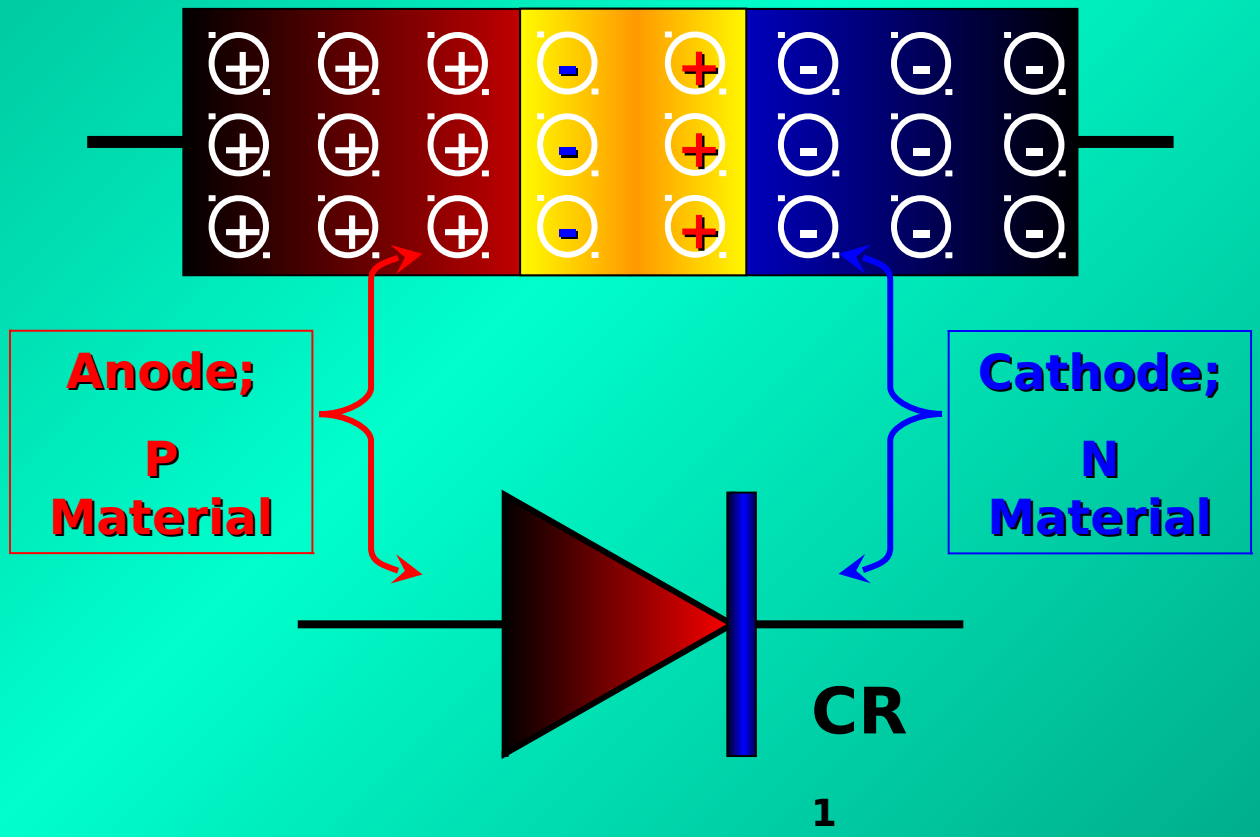
Diode Letter & Schematic Symbol: $CR_{1, 2, \ldots}$



Ohms Check

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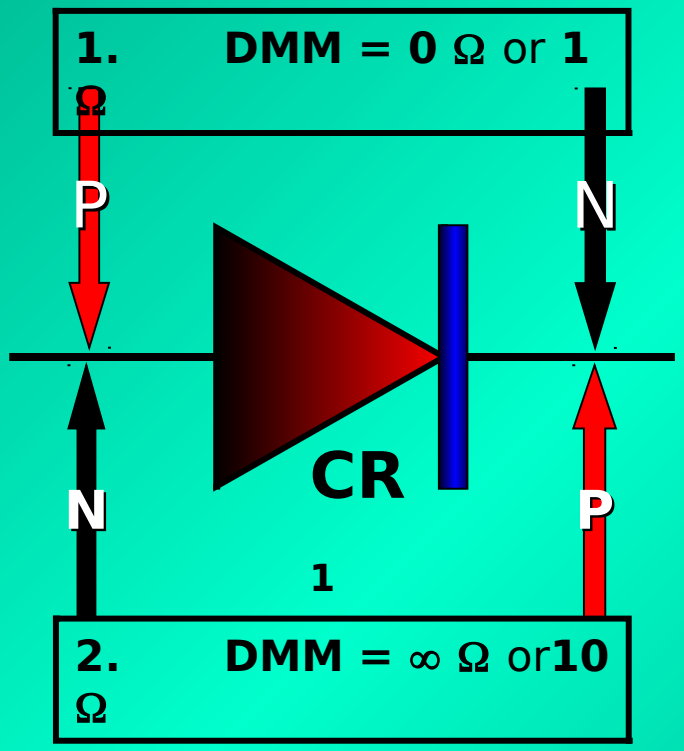
Diode Ohms Check:

2 Checks preformed on each element, by reversing the leads on the DMM.



Normal: **0/∞ Ω** or **1:10 Ω ratio**

Open: **∞ / ∞ Ω**

Short: **0/0 Ω**

Diode Series Ckts

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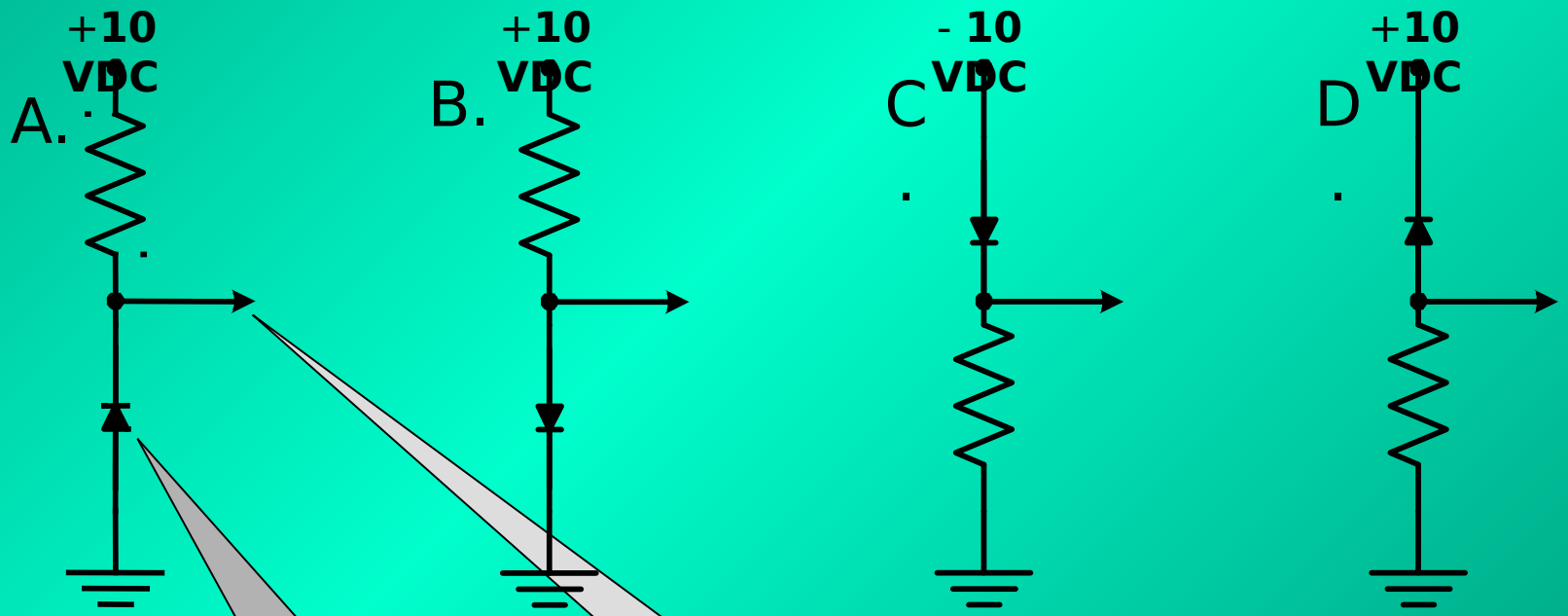
Voltages At The Test Point:



+ Limiter

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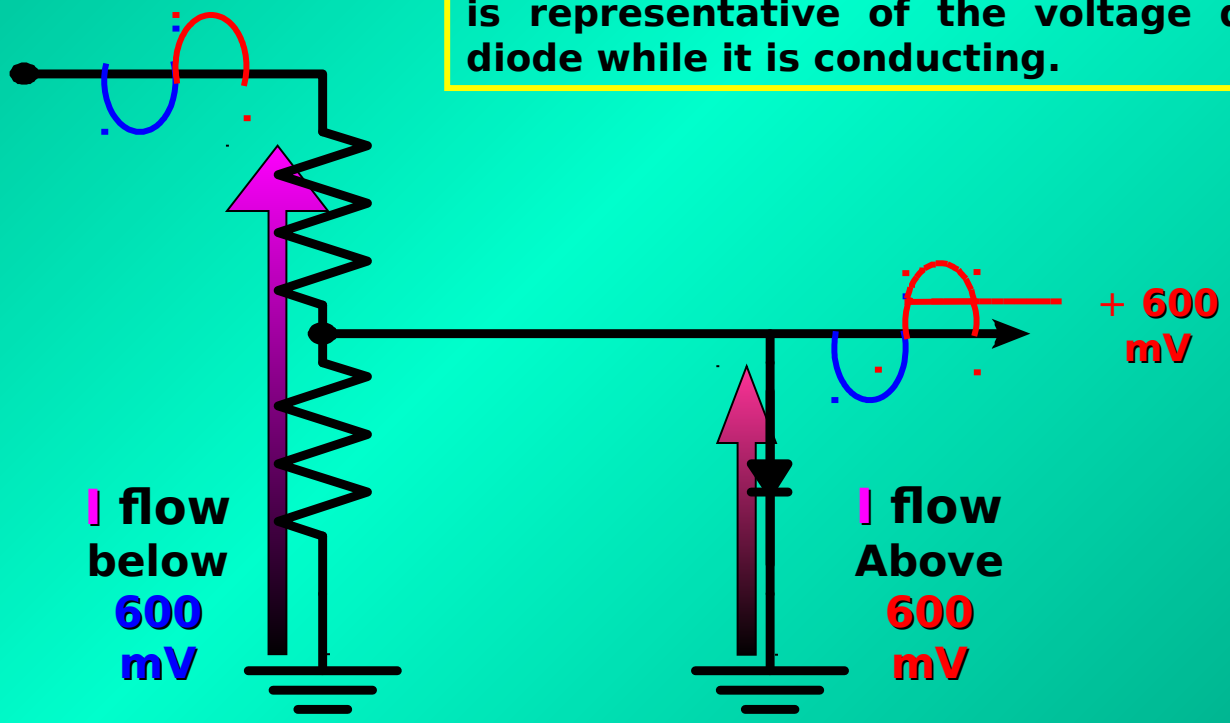
Positive Half-Wave Limiter:

Current flows thru the resistor until +600 mV is reached, then flows thru the Diode. The plateau is representative of the voltage drop of the diode while it is conducting.



- Limiter

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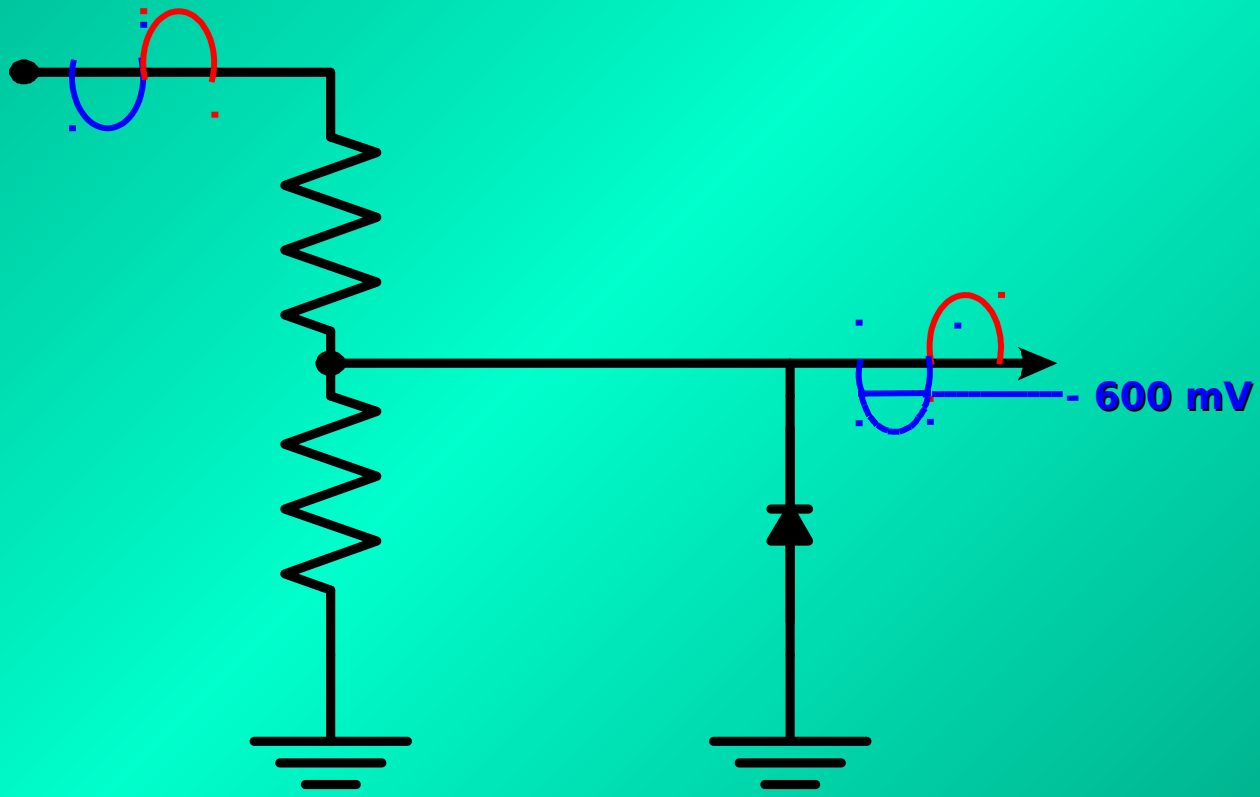
Negative Half-Wave Limiter:



+ & -
Limiter

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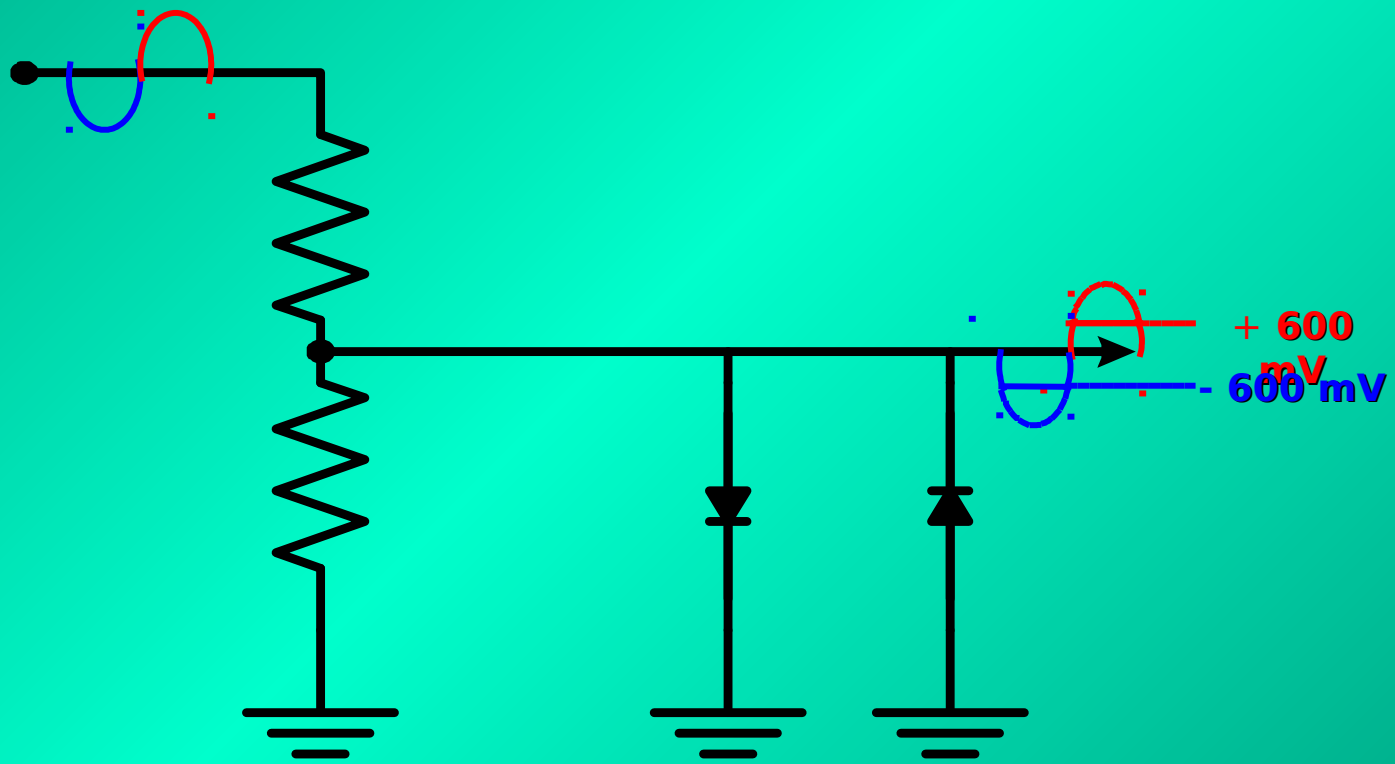
Positive & Negative Half-Wave Limiter:



Review ?

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Review Questions; 1- 9

1. A device that has the ability to pass current through it in only 1 direction is called a _____ _____ .
2. Charged particles [atoms] are called _____ .
3. What is Bias? _____ .
4. The process of adding _____ to pure crystals is called _____ .
5. The 2 Types of current are _____ & _____ .
6. The area formed on each side of the P N Junction is called the _____ _____ .
7. A Difference of _____ exists across this region.
8. The _____ generated across the _____ region is referred to as a Junction Barrier Potential.
9. Connecting an external power source across a PN Junction is called _____ .

Answers

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Review Questions; 10 - 17

10. When a diode is reversed biased, the depletion region is very _____ and resistance is _____ .
11. A semiconductor diode is said to be good if the front to back ratio is at least ___ : ___ .
12. If PIV is exceeded, a diode can be _____ .
13. All elements fall into 3 electrical categories: _____ , _____ , _____ .
14. When a material has excess electrons after doping, it is referred to as _____ or __ type material.
15. Electrons & Holes move in opposite directions through a semiconductor material.
16. What is the purpose of a limiter circuit? _____ .
17. What condition describes a forward biased semiconductor Diode? _____ .

Answers

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Lesson Test:

Lesson Test:

Standard: 10 Questions W/in 20 Minutes. 7 of 10 correct.

Reference: W/O Reference.